



Armed Forces College of Medicine AFCM



Thermal and pain sensations



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INTENDED LEARNING OBJECTIVES (ILOs)



By the end of this lecture the student will be able to:

1. Describe thermo-receptive sensations.
2. List the general criteria of pain.
3. Explain primary and secondary hyperalgesia.
4. Compare superficial and deep pain



Lecture Plan

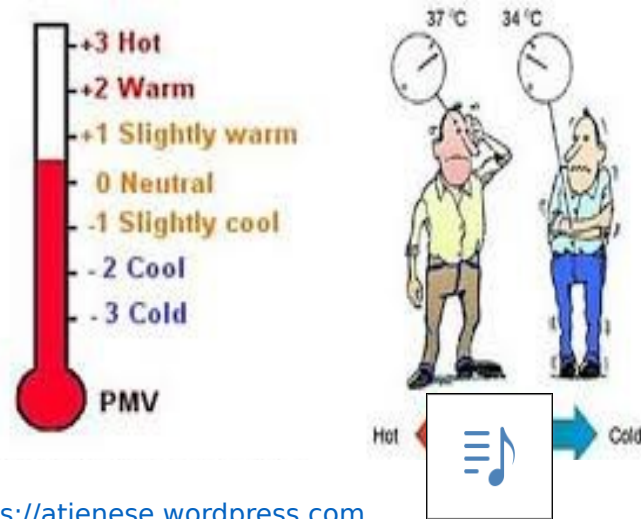


1. Thermal sensation (15 min)
2. Pain & hyperalgesia (25 min)
3. Summary (5 min)
4. Lecture Quiz (5 min)

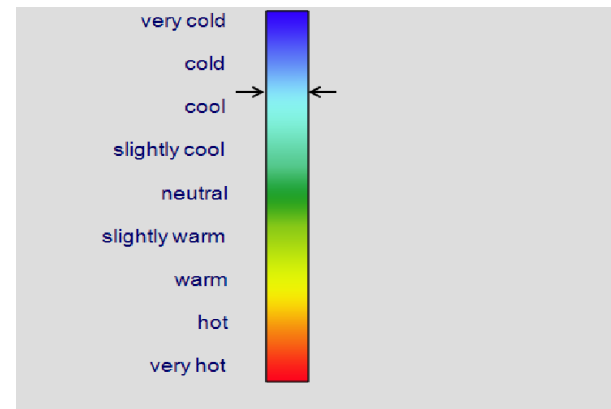
Thermoceptive Sensation



**conscious
perception
of
different
grades of
environme
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temperatu
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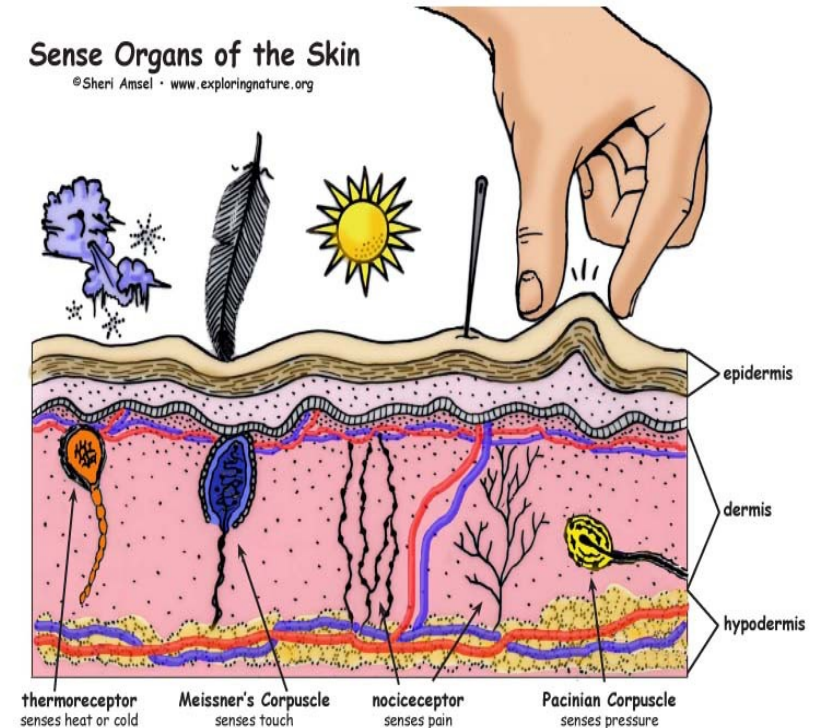


<https://atjenese.wordpress.com/2012/05/04/the-assessment-of-thermal-comfort-of-living-environment-in-tsunami-disaster-place/>



. Thermal sensation scale

<https://www.semanticscholar.org/paper/Thermal-sensation-and-comfort-models-for-and-Part-Zhang-Arens/6dab41f9689c769f7651620e315c7e71f3d63486/figure/2>



<https://www.exploringnature.org/db/view/Sense-Organs-of-the-Skin>

Thermoreceptors



Types

warm

- Free n. endings (*C fibers*)

Cold

- Free n. endings (*C & A δ fibers*)



Cold pain

- Stimulated by *extremes* of temp.

Warm pain

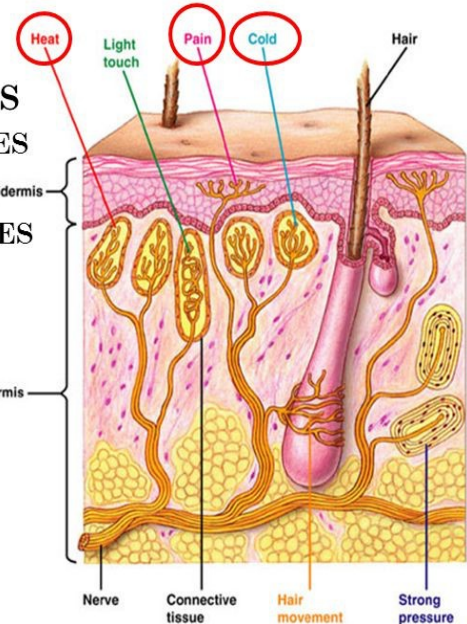
OTHER SKIN RECEPTORS

◦ THERMORECEPTORS

- KRAUSE CORPUSCLES
 - Cold
- RUFFINI CORPUSCLES
 - Heat

◦ PAIN RECEPTORS

- Free nerve endings



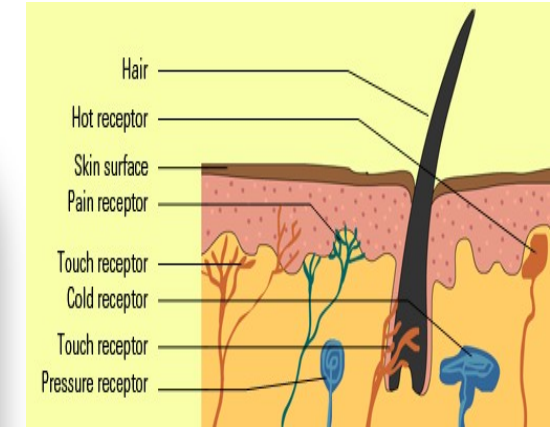
<https://slideplayer.com/slide/2385462/8/images/29/SKIN+SENSORY+RECEPTORS.jpg>

Thermoreceptors

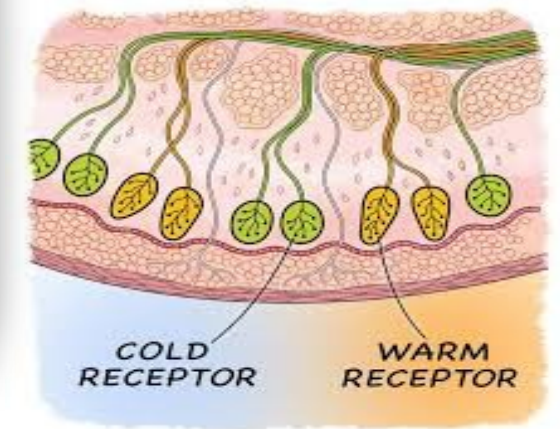


Distribution

- ❑ Immediately **under the skin** (respond to **temp. of SC tissue** around not ??).
- ❑ Distribution **differ** in different parts of the body**greatest** in **lips** **moderate** in **finger tips** **least** in **trunk**.
- ❑ Cold receptors >>>> warm receptors (**4-10** times).
- ❑ Widely **separated**. (**wide area** of skin has to be exposed to differentiate different degrees of temp.).



<https://eschooltoday.com/science/the-five-senses/the-sense-of-touch.html>



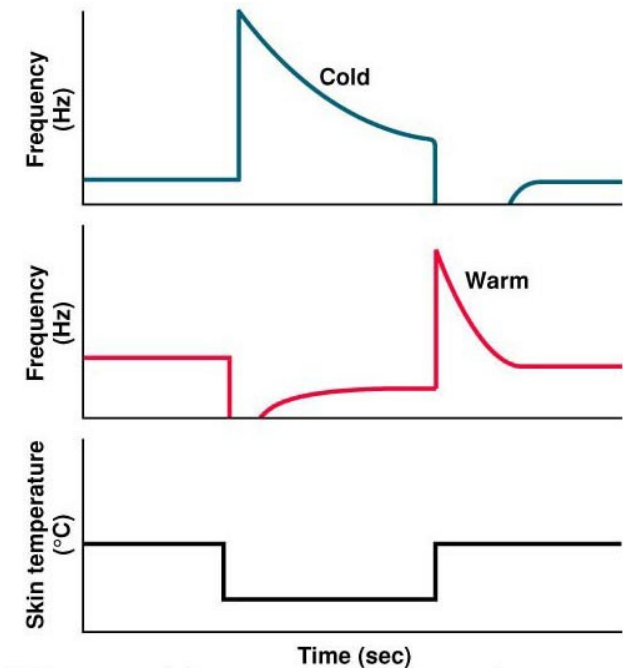
<https://www.scientificamerican.com/article/cold-or-warm-can-we-really-tell/>

Thermoreceptors



Adaptation

- o **Moderately** adapting but warm receptors **faster** than cold R.
- o Respond markedly to **changing** temp. rather than steady temp.

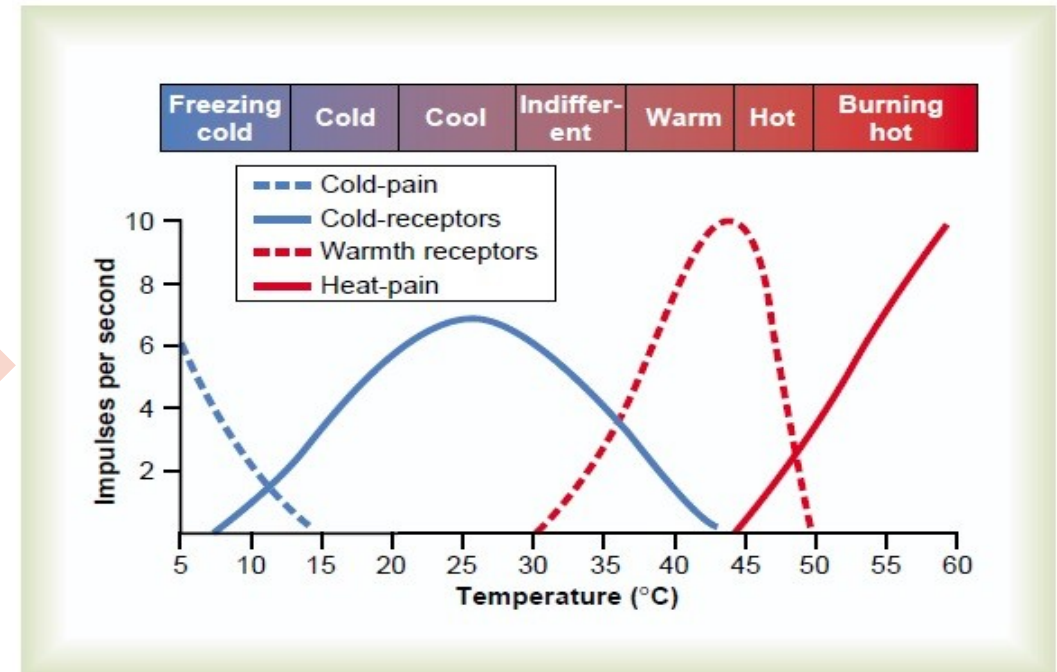


<https://www.d.umn.edu/~jfitzake/Lectures/UndergradPharmacy/SensoryPhysiology/Somatosensation/TempPerceptionExp.html>

Detection of thermal sensation



- ✓ 5-15°Ccold pain R.
- ✓ 10-40°Ccold R.
- ✓ 30-50°Cwarm R.
- ✓ $\geq 45^\circ\text{C}$ warm pain R.
- ✓ 0°C Anaesthesia NO receptor discharge
- ✓ 35°C Neutral (**comfort zone**) ??



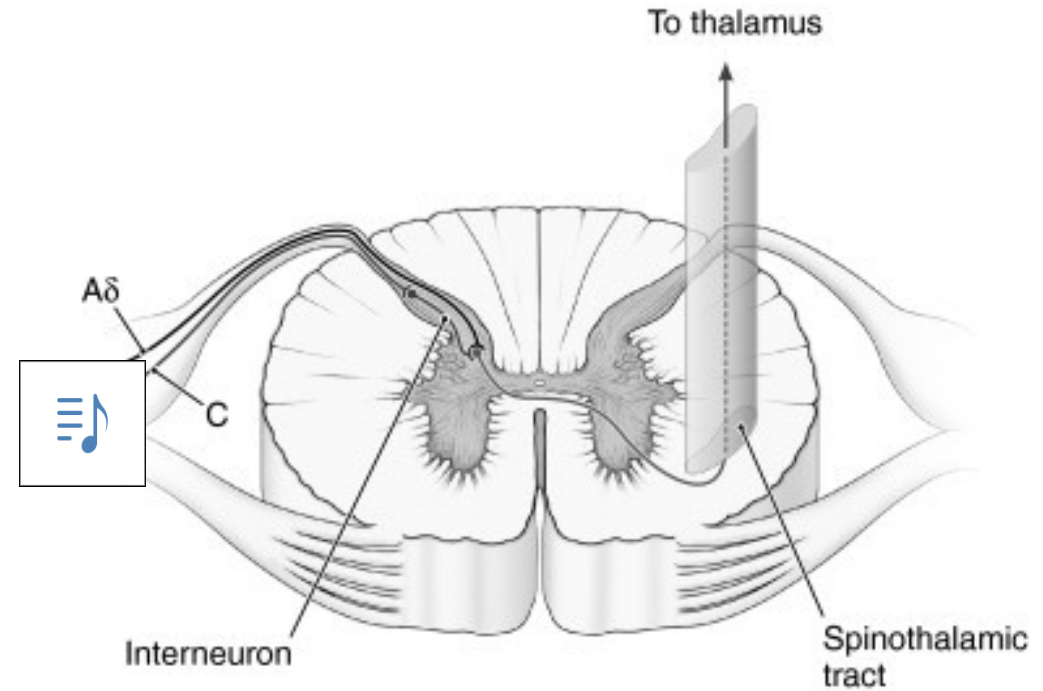
https://www.brainkart.com/article/Thermal-Receptors-and-Their-Excitation_19664

Thermoceptive Sensation



Pathway

lateral
spinothalamic tract



<https://www.sciencedirect.com/topics/medicine-and-dentistry/thermoreceptor>

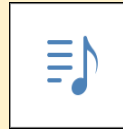


different types of thermoreceptor

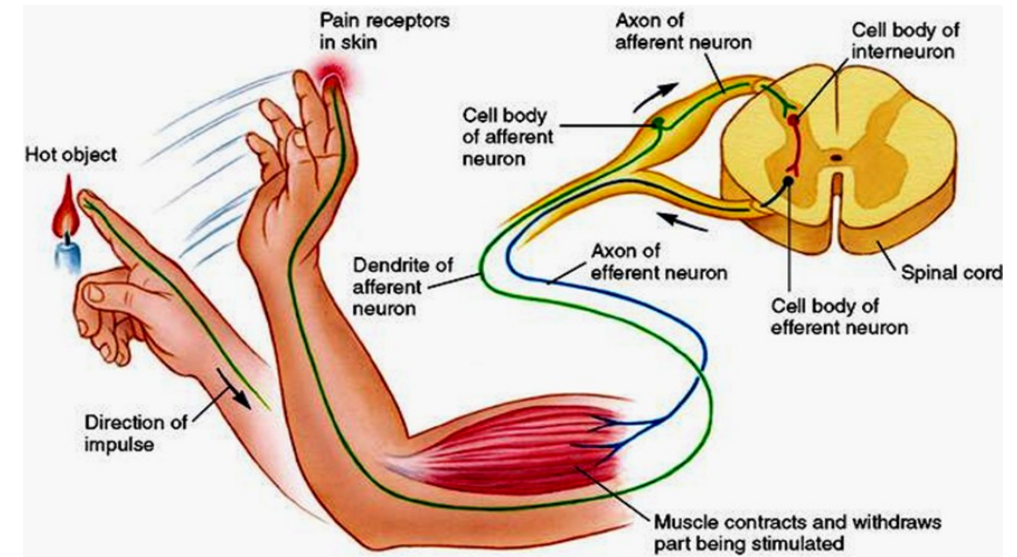
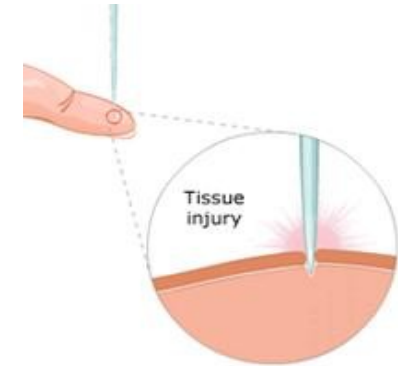
Pain



- ❑ **unpleasant** sensory and emotional experience.
- ❑ physical or potential **tissue damage**.
- ❑ For **protection** of the body (enable protective & behavioral response preventing further tissue



d. ✓ **Receptors:** *Free n. endings ($A\delta$ & C fibers)*



<https://www.examrace.com/Study-Material/Medical-Science/Physiology/Reflex-Act>

Pain receptors (**Nociceptors**)



Types

mechanical

- Respond to **strong mechanical** forces (cutting, pricking)

thermal

- Respond to **extremes of temp.** ($>45^{\circ}\text{C}$ & below 15°C)

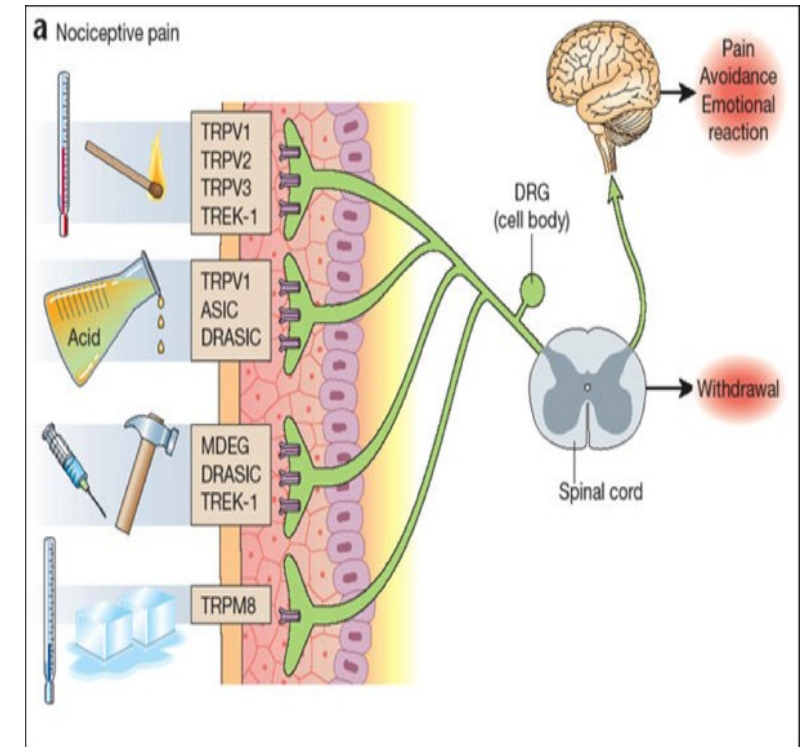


chemical

- Respond to injurious **chemicals** & those produced from **tissue damage**

polymodal

- Respond to **all stimuli**.



<https://www.animescience101.com/congenital-insensitivity-to-pain/pain-receptors>

Pain receptors (**Nociceptors**)



Distribution

- ❑ **Most numerous** in the **skin**
- ❑ **Abundant (numerous)** in **peritoneum**, pleura, periosteum, joints, arterial walls, dura and tentorium of the cranial cavity.
- ❑ **Few** in **deep tissues** and all **viscera** (for pain to occur, painful stimulus must be intense & widespread).
- ❑ **Absent** in **liver** parenchyma, **lung** alveoli, and **brain** tissue (**pain insensitive structures**).

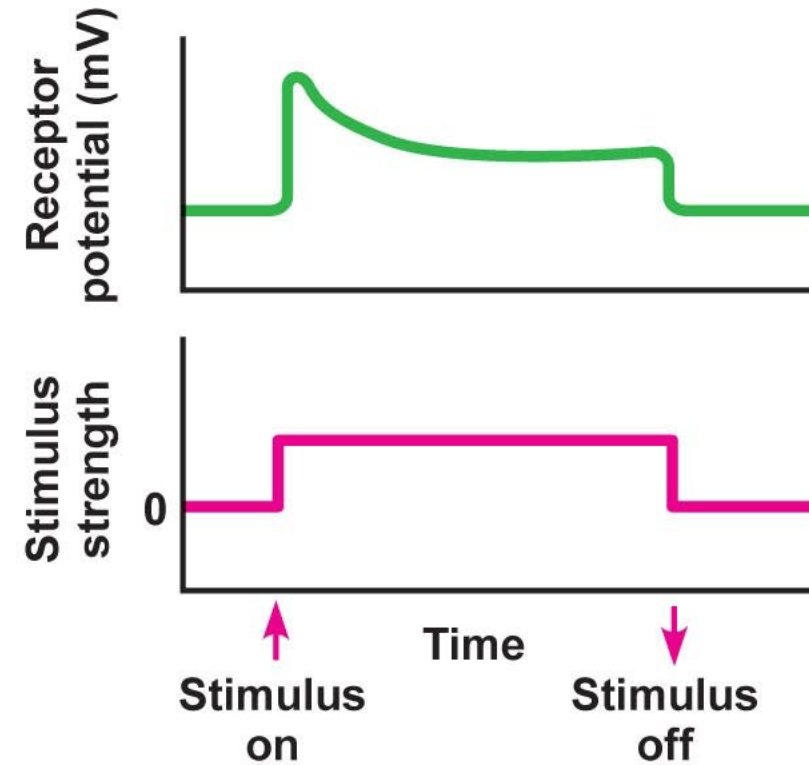


Nociceptors



Adaptation

- o Slowly or Non-adaptive receptors

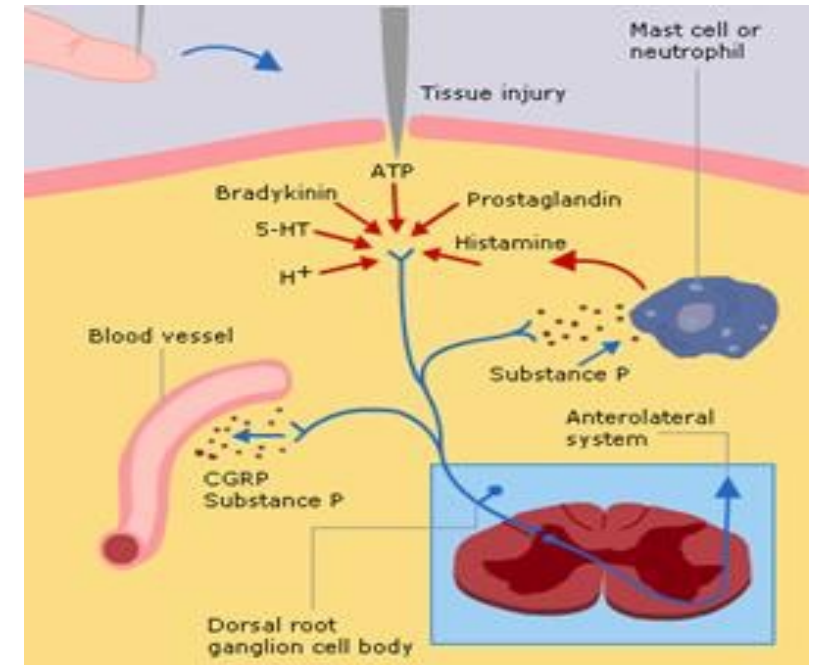


http://droualb.faculty.mjc.edu/Course%20Materials/Physiology%20101/Chapter%20Notes/Fall%202011/chapter_10%20Fall%202011.htm

Pain sensitizers



- pain and inflammation producing **chemical substances** released from the **damaged tissues** and the surrounding **blood vessels** **When??**
- **lowering pain threshold** of nociceptors (sensitization) □ primary **hyperalgesia** □ often accompanies pain.
- include histamine, serotonin, K⁺, substance P, ATP, bradykinin and prostaglandins (**Salicylates & NSAID ??**)



<https://www.rcemlearning.co.uk/reference/pain-management-in-adults/#1570786515026-faa7a79>

Cutaneous hyperalgesia



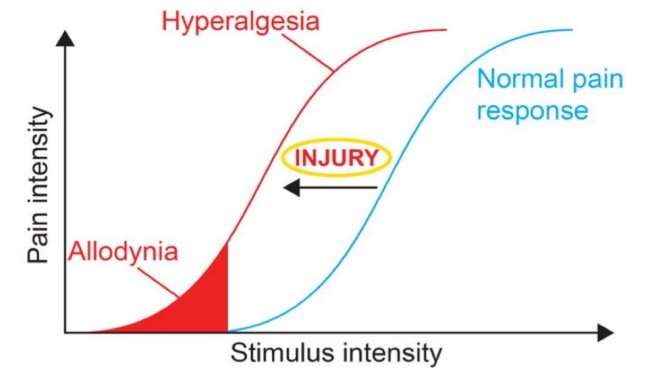
Def.

Exaggerated response to a noxious stimulus = increased pain sensitivity = an already painful stimulus now producing a **more severe type of pain. DD.**

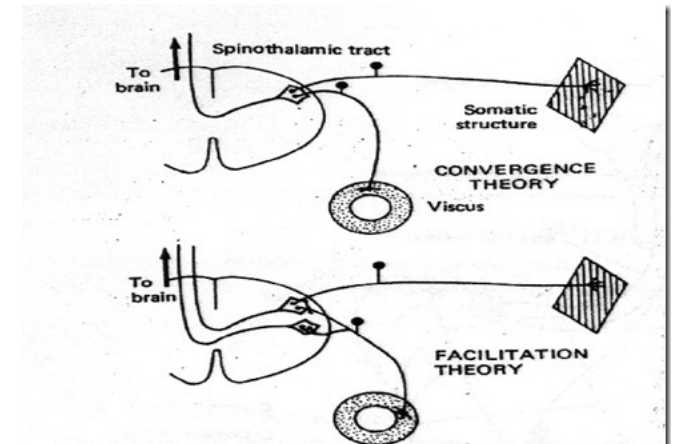
Allodynia ??

Types

| | Primary hyperalgesia | Secondary hyperalgesia |
|-----------------------|----------------------|--------------------------------------|
| Site | injured area | healthy skin around the injured area |
| Pain threshold | Decreased | Normal may be even increased. |
| Duration | Longer | Shorter |
| Mechanism | Sensitization theory | Convergence- facilitation theory |



<https://www.youtube.com/watch?v=zfqqi-sWZPQ>



<https://medatrio.com/pain-nociception>

Types of pain (fast /slow)



Quality

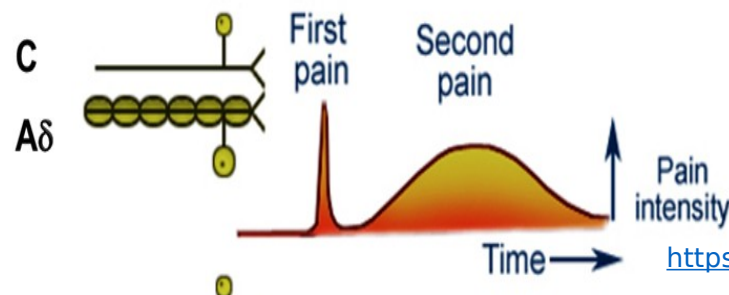
| Fast (Immediate) physiological pain | Slow (delayed) pathophysiological pain |
|--------------------------------------------------------------------------------------|------------------------------------------------------------|
| onset: during application of the stimulus | Shortly after application if tissue damage occurs |
| Duration: short duration. | Longer duration |
| Nature: pricking | Burning |
| Localization: well-localized | Poorly-localized |
| Afferent: A-delta fibers | C-fibers |
| Higher center: CC | Thalamus |
| Neurotransmitter: glutamate | Substance-P |
| Significance: * determine site & severity. * Initiate withdrawal reflexes. | * Associated with arousal, autonomic & emotional reactions |
| Abolished by deep pressure and not abolished by morphine. | Abolished by local anaesthesia & morphine |



| | Acute (Fast) | Chronic (Slow) |
|------------------------|----------------------------------|---------------------------------------|
| Source | Skin only | Skin, deep tissues, and viscera |
| Quality | Pricking | Burning |
| Onset | Within 0.1 sec after stimulation | One or more seconds after stimulation |
| Duration | Short (one second) | Long (few minutes) |
| Localization | Well -localized | Diffuse |
| Afferent | A-delta | C |
| Tract | Neospinothalamic tract | Paleospinothalamic tract |
| Centre | Cerebral cortex | Thalamus |
| Chemical trans. | Glutamate | Substance P |

<https://www.slideshare.net/medicmesirmansurah/pain-3353946>

<https://slideplayer.com/slide/4900931/>



<https://wellnessdoctorrx.com/neurophysiology-pain-part-i/>

Types of pain (**cutaneous** / **deep** / **visceral**)



origin

Cutaneous pain

- From **skin** and **subcutaneous** tissues
- Usually **pricking** or **burning** pain

Deep pain

- From **structures deep to the skin** e.g. skeletal ms, joint tendons
- Usually **dull aching** or **throbbing**



Visceral pain

- From **internal viscera** e.g. stomach
- Usually **colicky** or **dull aching**

Cutaneous pain is accurately localized:

Why??

- ✓ ++ pain receptors in skin
- ✓ Reaches sensory cortex
- ✓ Touch & vision help localization

<https://slideplayer.com/slide/4900931/>

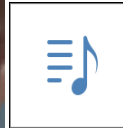
Causes of deep pain



1-Trauma



2- Inflammation



<https://www.medicalnewstoday.com/articles/321835.php>

3- Ms. spasm



4-Ischemia





Enumerate types of pain.

Lecture Quiz



Pain produced by tissue damage is due to release of which of the following?

a. Excess norepinephrine.

b. Bradykinins.



c. Heparin.

d. ATP.

Summary



- Thermoceptive sensation is conscious perception of different grades of environmental temperature.**
- Thermoreceptors include warm, cold, warm pain & cold pain receptors.**
- Distribution of thermoreceptors differs in different parts of the body.**
- They are moderately adapting receptors.**
- Thermal sensation is transmitted along lateral spinothalamic tract.**
- Pain is unpleasant sensory and emotional experience.**
- Pain receptors include thermal, chemical, mechanical & polymodal receptors.**
- Distribution of pain differs in different parts of the body.**
- Pain receptors are slowly or non-adapting receptors.**
- Pain sensitizers are chemical substances released from the damaged tissues and the surrounding blood vessels.**

Lecture Quiz



Which of the following is correct regarding slow pain?

a. Is carried along type A fibers.

b. Is perceived mainly in sensory areas



c. Its pathway activates non specific thalamic nuclei.

d. Lasts for a short time.

SUGGESTED TEXTBOOKS



1. Guyton and Hall Textbook of Medical Physiology.

<https://www.amazon.com/Guyton-Hall-Textbook-Medical-Physiology/dp/1455770051>

2. Ganong's Review of Medical Physiology, 25e.

<https://www.amazon.com/Ganongs-Review-Medical-Physiology-Twenty-Fifth/dp/007182510X>



**Thank
you!!**